

## **Undergraduate Research Program in the Basic and Applied Sciences at Middle Tennessee State University**

**B. S. Sridhara**

**Middle Tennessee State University**

### Abstract

The college of Basic and Applied Sciences at Middle Tennessee State University (MTSU) has ten departments including Biology, Chemistry, Computer Science, Engineering Technology and Industrial Studies, Mathematics, and Physics and Astronomy. In the fall of 1993, our college dean initiated the Basic and Applied Sciences undergraduate research program at MTSU. The author was nominated to serve on the college undergraduate research committee (URC). The committee members had the privilege of attending a national conference on undergraduate research in June 1994 held in Lewiston, Maine. This helped us a lot in developing guidelines for our undergraduate research activity. Typically we invite research proposals from students in the fall semester. URC members contact students directly, and through colleagues and department chairs. Students are required to write proposals with the help of their faculty mentors and submit them in the first week of November. Committee members review the proposals, rank them and meet to decide on awards in December. Awardees are notified in the second week of December and they are required to complete their research before the end of the next summer and submit a report in the fall. We started with a budget of \$3000 to award five grants in 1995 and this year we have \$10,000 to award twelve deserving students. In the spring of every year we hold the college undergraduate research symposium at which all grant recipients and other students present their research at the poster session. We invite the local engineering and science community and high school students to this event. Faculty members from different departments in the college judge the presentations and the top three will receive cash prizes. The grant recipients also get a chance to publish their research in "Scientia", the college electronic journal for student research. We have worked with our Engineering Technology students and submitted several proposals and some of them have received grants. Two of the author's advisees not only received the undergraduate research award, but also won the first and second prizes at the college research symposium. One student published his research in Scientia and made a presentation at the MTSU Founders Day and later served as the editor of Scientia. The other student extended his research to solve a manufacturing problem for some local industry and also got a chance to make a presentation at the MTSU Administrative Retreat.

## I. Introduction

Undergraduate research should be an important part of our Engineering Technology (ET) curriculum because it better prepares our students for the graduate school. This additional experience also helps our majors in their career regardless of the job type because they learn to work independently as undergraduate researchers. However, it has been our observation that ET students are far less motivated to do research and report writing than those in other fields such as Biology, Chemistry and Physics. This is more apparent at Middle Tennessee State University (MTSU) since we have a large number of non-traditional students many of whom work full time and have a family. Therefore, faculty members have to take the additional responsibility of identifying potential undergraduate researchers and mentor them. Both faculty and students need proper resources and support from the university to carry out this task.

The College of Basic and Applied Sciences (CBAS) at MTSU has ten departments including Aerospace, Agribusiness and Agriscience, Biology, Chemistry, Computer Science, Engineering Technology and Industrial Studies (ETIS), Mathematics, Nursing, and Physics and Astronomy. In the fall of 1993, our college dean initiated the Basic and Applied Sciences undergraduate research program at MTSU. He appointed a committee with the objective of developing a college level research program. The author was nominated to serve on the college undergraduate research committee (URC) and has been a URC member for the last ten years. In the following few months the committee met several times with and without the college dean, did some brainstorming and decided to study such programs at other universities in the United States. Some URC members were selected to attend the Council of Undergraduate Research (CUR) annual conference that was held June, 1994 in Lewiston, Maine.<sup>1</sup> This three-day event was as big as the ASEE annual conference and exposition. There were several informative and useful sessions we could attend and the poster session for student presentations was particularly helpful. Based on the information obtained at this conference and from several other sources the undergraduate research committee stated its mission as to promote, facilitate and showcase undergraduate research in the sciences at MTSU. In 1994 October, our first call for research proposals from CBAS students was sent out and grants were awarded to meritorious proposals in December. In 1996 it was decided to hold a college level undergraduate research symposium in the spring of every year to showcase student research including those projects funded by the URC.

## II. Undergraduate Research Grant Process

The URC which has one chair and eight other members normally meets twice in the fall semester. In the first meeting we discuss the last year's undergraduate research activities including the number of proposals received and funded, the quality of proposals, the number of submissions from each department, and the current status of each funded proposal. The committee discusses different new and improved ways to involve more students and faculty in undergraduate research. We review the current proposal format to see if it requires updating and also discuss the funding situation for the current year. Normally the college dean attends this mid October meeting. The URC chair sends out an e-mail to all Basic and Applied Sciences department chairs and faculty inviting proposals. In this communication the chair asks them to identify potential students, motivate them, help find a suitable research topic and assist in writing

a proposal. Contact information about each departmental faculty representative along with flyers and brochures that can be used for publicity is provided in this communication. The URC chair also provides the website address that gives additional information on the college undergraduate research and appropriate links to a downloadable (MS Word or PDF) grant application form. Prospective undergraduate researchers and their faculty mentors are given approximately six weeks to submit their two-page proposal and the application form. During this time the URC members send several reminders to the faculty in their respective departments. They also talk to their colleagues and potential students, and make announcements in classrooms and labs. Additional information on undergraduate research at MTSU can be found at <http://www.mtsu.edu/~collbas/UndergradResearch/>.

In the application form, students are required to provide the title of project, their name, current address, phone number, e-mail address, department, expected date of graduation, and the name of supervising faculty member. The faculty member should certify that adequate resources are available for the successful completion of the project. Applicants should briefly outline their reasons for wanting to complete an undergraduate research project. Faculty mentors should provide an assessment of the proposed research project considering the following factors.

- a) The time period during which the student will work on the project
- b) The total amount of time the student is expected to spend on the project
- c) The total amount of time the faculty member is expected to spend on the project
- d) The percentage of time the student is expected to spend on related activities such as laboratory work or data gathering, data analysis, other computer work, library work, and report writing
- e) In what other journal or conference their work might be presented besides presenting at the CBAS undergraduate research symposium.

Undergraduate research committee members get copies of submitted proposals during the second week of November which they review and rank. In the December meeting the chair compiles the rankings from each member and presents the final standing of each applicant. The committee discusses the merits and shortcomings of each proposal and grants will be awarded depending on the current year's budget. The chair writes to all applicants in the second week of December thanking them for submitting a proposal and providing a feedback to those who did not receive the grant. We started with a budget of \$3,000 in 1995 and awarded three grants (\$1000, \$500 and \$350) out of the seven proposals that were submitted. The number of proposals has gone up to 20 over the last nine years while their quality has also greatly improved and the funding has been increased to \$10,000. In 2003-04 we received sixteen high quality proposals and awarded three \$1,000 grants, two \$750 grants and five \$500 grants. As there is some money available for one or two additional grants, we have asked the non recipients to resubmit their proposals considering the feedback provided by the URC. Expenses related to the undergraduate research symposium and student presentations at a national undergraduate research conference are also covered in each year's budget.

Grant recipients have the option of carrying out their research either in the following spring or summer and are required to submit the final report by the end of the fall semester.

Some departments such as Biology, Chemistry and Physics require their students to take a research seminar course in the fall semester. Senior projects from ET concentrations are also eligible for UR funding.

### III. Undergraduate Research in the Engineering Technology and Industrial Studies Department

The Engineering Technology program at MTSU has several on going undergraduate projects such as the Solar Bike, Moon Buggy, and NASA Robotics which are nationally sponsored by the Department of Energy and NASA. Our students have done very well in these races or competitions. However, we lag far behind the Chemistry, Physics, and Biology departments in terms of the number of undergraduate research proposals submitted and presentations made at the annual UR symposium. On the other hand, we have fared as well as the Agribusiness and Agriscience, Mathematics, and Nursing departments. It has been an uphill task to motivate our students to do research. So far our majors have submitted about ten proposals in the areas of computers, concrete industry, electronics, and fluid power and five of them have been funded. The Chemistry department has the largest number of UR proposals and presentations to its credit and our kudos are due to the highly motivated faculty mentors and students.

The author has been fortunate enough to serve as faculty mentor to four talented students and three out of the five submitted proposals have been funded in 1998, 1999 and 2001. One funded proposal was on intelligent suspension systems that would rely on a computerized unit of control to improve safety, handling and vibration levels. This research included performing an analysis in both active and inactive suspension systems and exposing the effects of shock and vibration on human beings. Another funded proposal was on implementing today's technology into yesterday's tradition (Figure 1). The objective of this research was also to help a local guitar manufacturing company with the inlay process of the costly mother-of-pearl in their guitars. Computer numeric controlled (CNC) machining and laser engraving techniques were used in the tests. Results showed that the inlays done using the new method last much longer than those done using the conventional techniques. This research project revealed that the existing two-week lead time can be cut down to 5 minutes per part, saving the guitar manufacturing company approximately \$140,000.00 per year on two stock items. One of the non funded proposals was on developing hardware and software to measure hydraulic cylinder speed. Results of this research were intended to be used in our fluid power lab. The objective of another proposal was to find an optimal solar array through a series of tests for use in a solar vehicle.

### IV. Undergraduate Research Symposium

This is an annual poster session held in April by the college of Basic and Applied Sciences at Middle Tennessee State University. The first research symposium was held in April 1996 with 12 presentations and we had 35 presentations in 2003. Each year the URC meets once or twice in the early spring to discuss several aspects of the event including the symposium venue, publicity, display arrangements, refreshments, invitees and budget. It has become increasingly difficult on MTSU campus to find a suitable hall at a convenient location to attract a large number of participants to attend this symposium. After our committee meetings the chair

sends out several e-mail messages to college department chairs and faculty members inviting abstracts from their students allowing about six weeks. All UR grant recipients are required to present their research at this two-hour session. Other students are encouraged to present their findings related to senior projects, research seminar courses, and extra curricular projects such as the Solar Bike, Moon Buggy, NASA Robotics, and Concrete Canoe.



Figure 1. Russell White working on his research, “Today's Technology Implemented into Yesterday's Tradition”

We award cash prizes for the top three presentations at the symposium and the amount varies from year to year depending on the budget. The nominal amounts are \$300, \$200 and \$100 for the first, second and third places, respectively. The cash prize is awarded based on the recommendations made by a group of judges. One faculty member from each CBAS department serves as a judge and the author was privileged to do this five times. In the first hour of the session, the judges go around listening to each student presentation, asking questions or seeking clarifications while commending the student for his or her dedication and hard work. They rank the presentations based factors such as the magnitude of the project, clarity of presentation, originality and practical applications. The URC chair and the judges meet to discuss the presentations and arrive at the final ranking. The chair announces the first, second and third prize at the end of the symposium. In addition, the first prize winner also gets approximately \$1000 to present his or her results at a national undergraduate conference. The author's two students who received the undergraduate research grant also won the first and second prizes at the CBAS research symposium (Figure 2).

We usually hold our college UR symposium one week before the graduate research symposium and the faculty research symposium which are two university wide events. The last two weeks of April are unofficially designated as research weeks at MTSU as the college of Liberal Arts also holds its annual research symposium during this time. Each year abstracts of the CBAS undergraduate research symposium are published in the spring issue of Scientia, a student electronic journal at MTSU.



Figure 2. Russell White won the first prize at the 2002 undergraduate research symposium

## V. Scientia

In 1996 the dean of Basic and Applied Sciences and two other faculty members initiated the concept of Scientia. The purpose of the journal is to:

- a) Disseminate important findings generated by student research
- b) Provide an opportunity for full student involvement in the final step of the scientific method, namely publication
- c) Serve as a public relations tool by showcasing the accomplishments of students
- d) Promote interdepartmental faculty and student collaboration

The dean appointed a board of faculty facilitators selecting one representative from each CBAS department. The author has been representing the Engineering Technology and Industrial Studies Department on the Scientia board since 1996. The function of a faculty facilitator is to

*“Proceedings of the 2004 American Society for Engineering Education Annual Conference & Exposition Copyright 2004, American Society for Engineering Education”*

identify and recruit talented students to serve on the Scientia editorial board. This board consists of an editor, an associate editor, a web site manager, an associate web site manager, and a reviewer from each department. The dean and faculty facilitators meet at least once in the fall and spring semesters. In the fall, students are nominated to different positions on the board and officers are elected. The main purpose of the spring meeting is to welcome the new editorial board members, and thank the outgoing staff. Additional information on Scientia can be found at <http://www.mtsu.edu/~scientia/>. Abstracts of undergraduate research presentation by Jeff Jorge and Russell White (the author's two advisees) can be found at this site.<sup>2,3</sup> Jorge also presented his research at the MTSU Founders Day. White presented his research to the local guitar manufacturing company and the ETIS industrial advisory committee as well as at the MTSU administrative retreat.<sup>4</sup>

Jorge served on the Scientia editorial board as the ETIS representative for one year and was appointed editor of the journal. He also published an article on his Solarraider II experience in this journal.<sup>5</sup> Undergraduate student teams at MTSU built three solar cars between 1994 and 1999 for competing in Sunrayce, a cross-country solar car race sponsored by the U.S. Department of Energy and General Motors. The Solarraider II (Figure 3) that was built in 1997 is the second car and the author had the privilege of serving as chief faculty advisor for all three Solarraider teams.



Figure 3. Jeff Jorge (extreme right) contributed enormously to the Solarraider II project at MTSU

Each Solarraider team consisted of 15-20 undergraduate students from the ETIS department. Dr. Saleh Sbenaty from the ETIS department served as a faculty advisor and helped the teams with electrical and electronics aspects of the solar cars. Mr. Steve Gossett who teaches in the Aerospace department at MTSU helped us with the composite fabrication of the main frame, body and array of the solar cars. We received a lot of help from many local industry including Astro-ProCraft, Southeastern Technologies, Mid South Metallurgical, Aerostructures Corporation, All Van Corporation, and MCW Industries. We received a lot of support from the ETIS chair, CBAS dean and MTSU Development Office. Additional information on our solar cars can be found in references 6 and 7.

## VI. Conclusions

We constantly encourage our students to get involved in undergraduate research. It is gratifying to learn that Jeff Jorge is currently working for Electronic Data Systems (EDS) and pursuing his MBA degree at University of Michigan. There are several interesting and challenging departmental undergraduate projects such as the Solar Bike, Moon Buggy, NASA Robotics, and Concrete Canoe. As URC members we work with the student teams and their faculty advisors involved in these projects and encourage them to apply for the college undergraduate research grants. We have also provided links on the college website to some successful UR proposals from different CBAS departments to help the prospective researchers. It is learned that a university wide undergraduate research program will be started in the fall of 2004 and it will be another source of funding and encouragement to our students. Currently, there are no undergraduate research programs in any of the other four colleges at MTSU although the college of Liberal Arts holds its UR symposium once in a year. The objective of this paper is to present the undergraduate research activities as they are carried out at MTSU. It is not surprising if some people do not find these activities interesting because not everyone has an aptitude for research. Let us hope this and other similar presentations will motivate more faculty and students to engage in research activities at various levels.

## VII. Bibliography

1. Council on Undergraduate Research annual conference, Bates College, Lewiston, Maine, June 1994.
2. Jeff Jorge, Jr. and Sid Sridhara, "Intelligent Suspension System," presented at the fourth undergraduate research symposium, Middle Tennessee State University, Murfreesboro, Tennessee, April 1999 ((Scintia, volume 3, issue 1).
3. Russell White and B. S. Sridhara, "Today's Technology Implemented into Yesterday's Tradition," presented at the seventh undergraduate research symposium, Middle Tennessee State University, Murfreesboro, Tennessee, April 2002 (Scintia, Volume 6, Issue 1).
4. Russell White and B. S. Sridhara, "Today's Technology Implemented into Yesterday's Tradition," presented at the Administrative Retreat, Fall Creek Falls, Tennessee, October 2002.
5. Jeff Jorge, Jr., "The SolaRaider II Experience," Scintia, Volume 1, Issue 2, Fall 1997, Middle Tennessee State University, Murfreesboro, Tennessee.



6. B. S. Sridhara, "Sunrayce 97 - A New Learning Experience for the Engineering Technology Students at Middle Tennessee State University," technical paper presented at the ASEE annual meeting held in Milwaukee, Wisconsin, June 1997.
7. B. S. Sridhara, "Curriculum integration of Engineering Technology courses with the solar car project at Middle Tennessee State University," technical paper presented at the ASEE annual conference held in Seattle, Washington, June 1998.

#### B. S. SRIDHARA

Dr. B. S. Sridhara is a professor in the Department of Engineering Technology and Industrial Studies at Middle Tennessee State University. He received his B.S.M.E. and M.S.M.E. degrees from Bangalore University and Indian Institute of Science, Bangalore, India. He received his M.S.M.E. and Ph. D. degrees from Stevens Institute of Technology, Hoboken, New Jersey, and Auburn University, Alabama. Dr. Sridhara has published several peer-reviewed articles in the areas of Acoustics, Vibration, finite element methods, and Engineering Education.